REMARKS

Claims 1-38 have been amended and remain in the application. Reexamination and reconsideration of the application, as amended, are respectfully requested.

Claims 1-3, 5-7, 9-32 were rejected under 35 U.S.C. 102(e) as being anticipated by Shirasaki. Claims 4 and 8 were rejected under 35 U.S.C. 103(a) as being unpatentable over Shirasaki. Claims 33-38 were rejected under 35 U.S.C. 103(a) as being unpatentable over Shirasaki in view of Ranalli (U.S. Patent No. 6,285,500).

These rejections are respectfully traversed with respect to claims 1-38, as amended.

The present invention, as defined by amended claims 1-38, is directed to a system comprising a number of elements in combination. In representative claim 1, for example, the combination includes a processor to process at least one collimated input beam to produce multiple time-delayed <u>output taps</u>.

As used in the present application, the term "output tap" refers to one of a plurality of light beams exiting the cavity that 1) is a collimated portion of a collimated input beam, including all input wavelengths, 2) comprises light that has a single time delay from the collimated input beam, 3) is individually accessible for modification or detection, and 4) where the input beam is characterized by collimation sufficient to maintain parallelism and insignificant spreading of the beam cross-sectional area over the distances of the entire system (thus enabling individual accessibility of each tap). The multiple time-delayed output taps in accordance with the present invention are spatially distributed and independently phase shifted. The multiple time-delayed output taps allow non-overlapping spatial access to each output tap. This, in turn, can be used to independently control the phase shift (and reflectance) of each output tap.

There is no teaching or suggestion in Shirasaki of a processor capable of processing a collimated input beam to produce multiple time-delayed output taps. There is no teaching or suggestion in Shirasaki of multiple time-delayed output taps.

Shirasaki instead discloses multiple virtual images (or replicas) of the input beam. Shirasaki (Figure 9) can be thought of as a diffraction grating with widely spaced steps, which yields large angular dispersion and output beams that are wavelength dependent (Figure 6). Having output taps in accordance with the present invention is like having access to the size and relative

location of each of the steps of a diffraction grating. Unlike a diffraction grating and unlike Shirasaki, the present invention provides a means to access and control each tap prior to (or without) overlap, interference, and the resultant formation of wavelength-dependent beams. The individual output tap access is enabled by creating multiple replicas (taps) of a collimated beam. The resultant collimated taps do not overlap. They can be individually adjusted in magnitude or phase. They can be individually processed (e.g., interfered with a second input beam).

Shirasaki fails to teach or suggest how to access each virtual image independently. Shirasaki fails to teach or suggest an optical tapped delay line enabling programmable or adaptive signal processing. The Shirasaki device does not provide access to individual taps.

The output luminous flux disclosed in Shirasaki is fundamentally different from an output tap in accordance with the present invention. Shirasaki's "luminous flux" is wavelength and angle specific. Shirasaki luminous flux is a collimated output flux of light formed by the coherent interference (referred to by Shirasaki as "strengthening") of light from most, if not all, of the virtual images. In contrast, output taps in accordance with the present invention are substantially parallel, contain all input wavelengths, and are time-delayed replicas of the input beam.

In Shirasaki, any one exiting luminous flux is NOT the result of any one particular virtual image, but a constructive interference from all the virtual images. This is a fundamental difference between the present invention and Shirasaki. Shirasaki's input beam does NOT remain collimated. Shirasaki creates new luminous fluxes that are collimated according to their wavelength (column 11, lines 38-41). The exiting collimated luminous flux is, in fact, a new beam created by constructive interference or what Shirasaki refers to as "strengthening." In contrast, the present invention enables phase modulation (or shifting) of multi-wavelength beams, including pulses.

Both the present invention and Shirasaki can accept collimated input beams. However, the present invention uses or acts on one or more two-dimensionally collimated input beams to create multiple time-delayed collimated output taps.

The present invention creates spatially separated (substantially non-overlapping and substantially parallel) multiple time-delayed output taps. Shirasaki does not. In the present invention, each non-overlapping output tap contains all input wavelengths, its output angle is not

determined by the wavelength(s) it contains, and the entire output tap is associated with the same specific time delay. Hence, with the present invention a particular output tap of particular delay can be spatially accessed and independently phase shifted at locations internal to the processor (e.g., element 305 of Figure 3) and at exit locations of the processor (e.g., elements 211a-m of Figure 2).

The independent, controllable phase shift is in addition to, and distinct from, the output tap-to-output tap dependent phase shift that is created by the relative time delays between output taps (see below). There is nominally no interference or "strengthening" of output taps in a particular direction internal to the processor or before the integration lens. Only with the multiple reflections of <u>collimated</u> light can one obtain the functionality of an OCDMA processor in accordance with the present invention.

There is no teaching or suggestion in Shirasaki of the advantages and widely ranging functionalities of processing output taps. In contrast, Shirasaki creates overlapping time-delayed virtual images that "radially disperse" from a focal line (column 8, lines 5-6) and therefore are certainly NOT collimated. Shirasaki provides no teaching or suggestion of multiple reflections of collimated beams, or of the advantages to be derived therefrom. Instead, Shirasaki states repeatedly that the input should be focused to a line, thus producing radially dispersed light from the virtual images that enables overlap in space and interfere with each other. The light from the radially dispersing virtual images overlap and constructively interfere (column 6, lines 16-19; column 8, lines 49-60) with each other (referred to as "strengthening" in column 7, line 55) at specific angles (based on input wavelength) and hence create new, overlapping, wavelength-specific luminous fluxes. Each <u>overlapping</u> output luminous flux is constructed from many virtual images. Each luminous flux is associated with a specific <u>wavelength and output angle</u> (column 5, lines 25-28; column 7, lines 22-25 and 50-52).

Additionally, Shirasaki's multiple time-delayed virtual image outputs overlap (they are present in the same 3-dimensional space, but travel in different directions). Consequently, in Shirasaki it is not possible to independently phase shift each one based on spatial position in or at the exit of the processor. Clearly, there is no teaching or suggestion in Shirasaki of a processor to process at least one collimated input beam to produce multiple time-delayed output taps, since such independent phase shifting is not possible.

The collimated output taps of the present invention allow non-overlapping spatial access to each output tap. This, in turn, can be used to independently control the phase shift (and reflectance) of each output tap. There is no teaching or suggestion in Shirasaki of independent phase shifting.

The Examiner notes that column 9, lines 46-47 of Shirasaki refer to: "... a VIPA [that] uses multiple reflection and maintains a constant phase difference between interfering lights."

Applicant submits that this is not a teaching or suggestion of independent phase shifting. Instead, Shirasaki is referring to a constant phase shift that is introduced because of the constant time delay that must occur between any constructively interfering virtual image outputs. In general, waves undergo a relative phase shift φ (in radians), given by $\varphi=2\pi f\tau$, when one of the waves at frequency f (cycles per second) incurs a differential time delay of τ relative to the other wave. The time delay differential between any two adjacent virtual images in Shirasaki is $2t\times\cos\theta$, where t is the distance between reflecting surfaces and θ is the propagation direction (angle) of the resulting luminous flux (Shirasaki's t from column 7, line 65). For "strengthening" or constructive interference to occur, Shirasaki states that this differential time delay, $2t\times\cos\theta$, must be a multiple of the wavelength of light or $m\lambda$. Hence, the "constant phase difference between interfering lights" that is disclosed in Shirasaki is not independently controlled for each virtual image. Rather, it is specifically set by the quantity $2t\times\cos\theta$ or multiple N thereof.

Shirasaki repeatedly emphasizes that the distance between reflecting surfaces, t, is constant (see Abstract; column 4, lines 9-15; column 12, lines 1-16; claim 2, etc.). In fact, Shirasaki specifically states (in column 8, line 1-5), that the propagation direction of the [output] luminous flux can be determined <u>if</u> t is constant. That is, Shirasaki relies on a constant t for proper operation. Given a constant time delay between any two virtual images, $N\times2t\times\cos\theta$, the phase shift $\varphi=2\pi f\times N\times2t\times\cos\theta$ associated with that time delay must also be constant and not independently controlled.

Unlike Shirasaki, the present invention provides for a means to independently control the phase shift of an output tap <u>in addition</u> to the phase shift provided by the time delay between output taps.

Moreover, amended claims 1–38 recite that each individual output tap can be phase modulated. Each output tap contains the entire optical spectrum of the input beam and hence the

phase modulator (shifter) is modulating all incoming wavelengths. The capability to access each output tap (or nearest equivalent, virtual image) is not provided by Shirasaki. Hence, there is a physical difference between the invention and Shirasaki.

Furthermore, a specific element has been shown and described in the specification for phase modulation. Namely, element 220 of Figure 2 and associated description "Upon exiting surface 204, the beams [output tap] may enter a phase modulator 220, where a unique phase shift is applied to each beam [output tap]." Hence, in the present invention each optical signal <u>output tap</u> is shifted in phase with respect to each adjacent <u>output tap</u> (not wavelength as stated by the examiner in Lines 8-10 of page 3 of the Office Action).

Shirasaki fails to disclose or suggest that the structure disclosed therein can be used to modulate in the spectral domain.

To clarify, Shirasaki fails to teach how to implement modulation in the spectral domain, where modulation in the spectral domain refers to modulation or shifting of the phase of different spectral components of the input signal (input beam). For example, if the input beam contains 3 wavelengths $\lambda 1$, $\lambda 2$, $\lambda 3$, then spectral phase modulation would be imparting different phase shifts $\alpha 1$, $\alpha 2$, $\alpha 3$ onto wavelengths $\lambda 1$, $\lambda 2$, $\lambda 3$, respectfully. Phase modulation refers to all types of phase changes, especially time-varying phase changes. Phase shifting in this context is simply a constant (or "dc" or zero frequency) phase modulation, where a constant phase shift is introduced. Hence, the applicant is claiming that Shirasaki fails to teach a system, method or technique to impart spectrally phase modulation onto the signal as the signal passes through the processor. The input signal itself may (and usually does) already contain information and therefore may contain some form of spectral phase modulation.

Claims 4 and 8 were rejected as being obvious in view of Shirasaki. The Examiner asserted that the use of an etched plate to introduce phase shifts would have been obvious to one skilled in the art.

This rejection is respectfully traversed with respect to claims 4 and 8, as amended. In Shirasaki's use of the multi-reflection processor, unequal phase shifts would specifically be avoided. If the virtual images are not created along a straight line (say, in Figure 7 or 9), then the strengthening phenomenon would not occur. That is, there would be few or no angles that light

from all the virtual images would strengthen or constructively interfere. This unequal spacing would be similar to a grating with lines that are not equally spaced. Hence, there would be no useful collimated luminous flux output from the processor and such an etched plate would render Shirasaki useless.

Furthermore, Shirasaki states (column 12, lines 19-23): "In Fig 14, VIPA 76 is shown as having transparent blocks 202 and 204 with reflecting films 122 and 124 formed thereon. Transparent blocks 202 and 204 are not intended to be limited to a 'block' shape, and can instead have any suitable shape." Shirasaki's reflecting surface could be a rectangular block, a circular disc, a thin-film membrane, etc.—all shapes that can create reflections and transmitted lights that interfere with each other to produce an output light which is spatially distinguishable from the input light (a phrase taken from Shirasaki claim 1). An etched plate in the Shirasaki processor would cause destructive interference and thus scatter the input light and not create the intended collimated, wavelength-specific output luminous flux. Hence, (1) the overlap prevents the Shirasaki processor from being usable as an OCDMA processor and (2) the introduction of such an etched plate would render the Shirasaki device useless. The inventions defined by claims 4 and 8 are neither disclosed nor suggested in Shirasaki.

The fundamental deficiencies with Shirasaki are not compensated for by the additional reference of Ranalli. There is no teaching or suggestion in either Shirasaki or Ranalli, alone of in combination, of a processor to process at least one collimated input beam which has been modulated with a data signal to produce multiple time-delayed output taps, the multiple time-delayed output taps being spatially distributed and independently phase shifted

In view of the above, each of the presently pending claims in this application is believed to be in immediate condition for allowance. Accordingly, the Examiner is respectfully requested to withdraw the outstanding rejection of the claims and to pass this application to issue. If it is determined that a telephone conference would expedite the prosecution of this application, the Examiner is invited to telephone the undersigned at the number given below.

In the event the U.S. Patent and Trademark office determines that an extension and/or other relief is required, applicant petitions for any required relief including extensions of time and

authorizes the Commissioner to charge the cost of such petitions and/or other fees due in connection with the filing of this document to Deposit Account No. 03-1952 referencing docket no. 509622000700.

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